

## Survey methodology

Bathymetric data were acquired with an Innerspace-448 precision survey echosounder (3-deg narrow-beam transducer) fixed to a 26-ft survey vessel. The echosounder and positioning equipment were interfaced to a computer-based data acquisition system running HYPACK (Coastal Oceanographics). A Trimble DSM-Pro DGPS receiver linked to the U.S. Coast Guard differential correction signal at Fort Stevens, Oregon, continuously provided position information. This positioning system provided continuous submeter horizontal position accuracy for all data collection. Soundings were corrected for vessel heave by an onboard heave/pitch/roll sensor (Seatex MRU-5).

Horizontal positions were logged as x- and y-coordinates in feet using the North American Datum of 1983 (NAD 83) and the Washington State Plane Zone #4602 (south). Depth values were logged in feet referenced to mllw and were corrected to the National Oceanic and Atmospheric Administration (NOAA) tide station at Toke Point using the integrated navigation software program HYPACK. Digitized depth soundings were checked against the analog record produced by the echosounder for additional quality control.

The WDOT Borrow Site survey area was established as a series of 65 parallel lines, oriented at 128 deg relative to true north, with 25-ft spacing between lines. This survey line configuration was established to be consistent with the predredging and postdredging surveys performed by David Evans and Associates, Inc., in June and July 1998. Surveys performed for the monthly monitoring of the Borrow Site were determined to require only a 100-ft line spacing. Therefore, every fourth line of the David Evans survey was run during each monthly monitoring survey. The horizontal extents of the survey are as follows:

- a. North Corner: 751588 E, 524629 N.
- b. West Corner: 752842 E, 523642 N.
- c. South Corner: 751837 E, 522365 N.
- d. East Corner: 750583 E, 523352 N.

Data quality was also verified by running survey lines oriented perpendicular to the primary survey lines ("tie lines"). All of the data acquisition systems, including the echosounder, heave/pitch/roll sensor, and the onboard computer systems, were calibrated before and after each hydrographic survey.

Hydrographic surveys of the Beach Nourishment Borrow Site (as of December 1998) were performed on 5 August, 4 September, 10 October, and 18 November 1998.

## Survey data processing and analysis

Data obtained in XYZ format from each survey were used to generate a grid with 5-ft spacing between nodes. The grid was rotated clockwise 52 deg about point (0, 0) of the Washington State Plane NAD 83 horizontal datum. The rotation was performed consistently for every survey to create regularly shaped rectangular grids (software limitations). This manipulation was required because the North Channel Borrow Site is aligned with the North Channel bottom

contours. This rotation changed the northings and eastings of each bathymetric data point.

After grid generation, color contour maps were generated. Figure 4-28 shows the contoured survey data grids for surveys performed in June (predredging), July (postdredging), August, and September 1998. Figure 4-29 shows the contour maps for surveys performed in October and November 1998. The color bar scales in these figures give the corresponding elevations in the area surveyed relative to mllw. A comparison of the predredging and postdredging contour maps shows where dredging occurred. The Borrow Site is approximately 24 acres in size and was dredged to depths as large as 70 ft (mllw) in some areas. Figure 4-30 shows the depth changes that occurred between the postdredging survey in July and the PIE survey on 18 November 1998. Sedimentation of up to 20 ft was noticed in some areas of the Borrow Site.

Ten cross sections were taken through the surveyed area at 150-ft spacing. Figure 4-27 shows the location of each cross-section. Figure 4-31 shows cross sections 1, 2, 3 and 4. Each cross-section plot shows bottom surface variation obtained for the predredging and postdredging during the August, September, October, and November 1998 surveys. The dredge cut and subsequent deposition are clear on most of the cross sections. Figure 4-32 shows cross sections 5, 6, 7 and 8, Figure 4-33 shows cross sections 9 and 10.

Table 4-12 shows calculated changes in depth along each cross section. The average change in depth was calculated only within the identified dredged area and not along the whole cross section. Further averaging was performed to determine the average change in depth over the entire dredged area. For example, the Borrow Site was dredged about 7.7 ft on average over the entire site. Approximately 1 ft of accretion occurred between the postdredging survey taken in July and the 5 August 1998 survey. During the following month, erosion of 0.7 ft was noticed between 5 August and 4 September, followed by accretion of 1.8 ft between 4 September and 10 October. The most recent monitoring period showed accretion of 0.3 ft (between 10 October and 18 November 1998). It should be noted that erosion took place over the entire survey area between 5 August and 4 September.

Table 4-13 presents the volume changes calculated in the dredged hole between consecutive surveys. These volume changes were calculated using cross sections 1-10. Approximately 350,000 cu yd were dredged from the borrow site for beach nourishment. However, the volume change between predredging and postdredging surveys is about 315,000 cu yd in the dredged hole. This discrepancy may be attributable to filling of the dredged hole during the month-long dredging process. The dredged hole experienced accretion of approximately 42,000 cu yd from July to 5 August. Between 5 August and 4 September, approximately 24,000 cu yd of material was eroded from the dredge hole. Between 4 September and 10 October and between 10 October and 18 November, accretion of approximately 70,000 and 9,500 cu yd occurred, respectively.

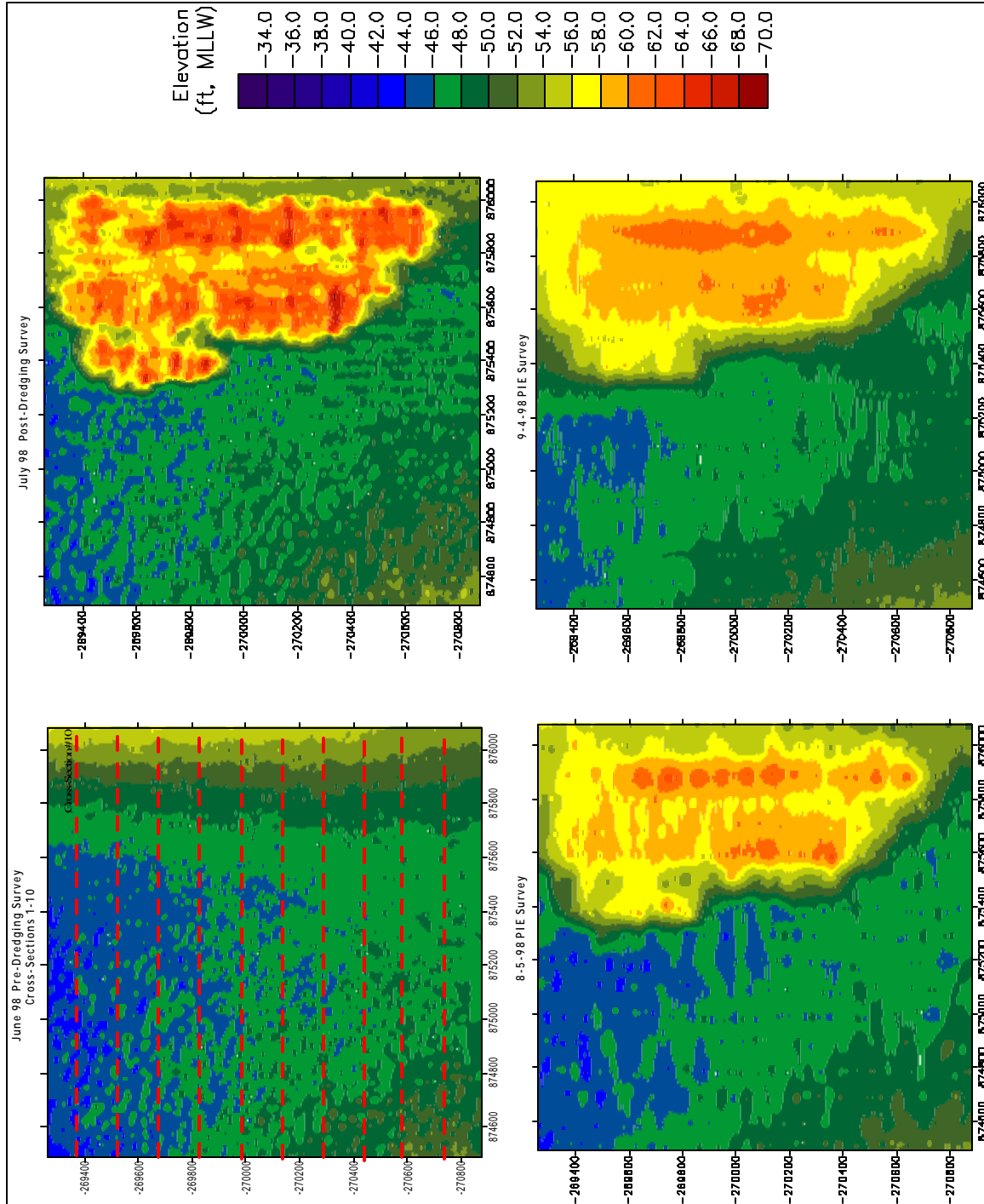


Figure 4-28. Contour maps of North Channel Borrow Site (predredging and postdredging, August and September 1998)

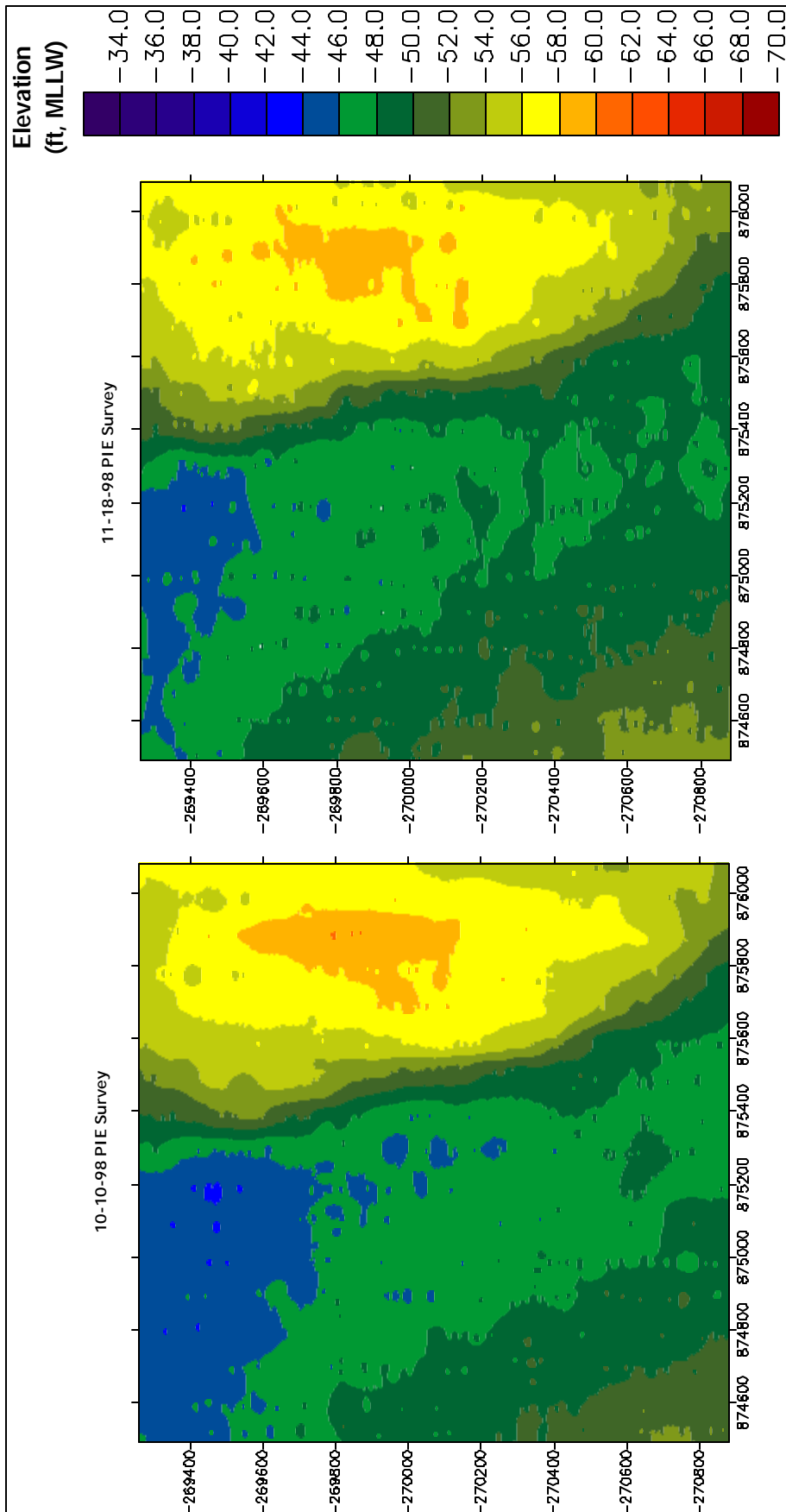


Figure 4-29. Contour maps of North Channel Borrow Site (October and November 1998)

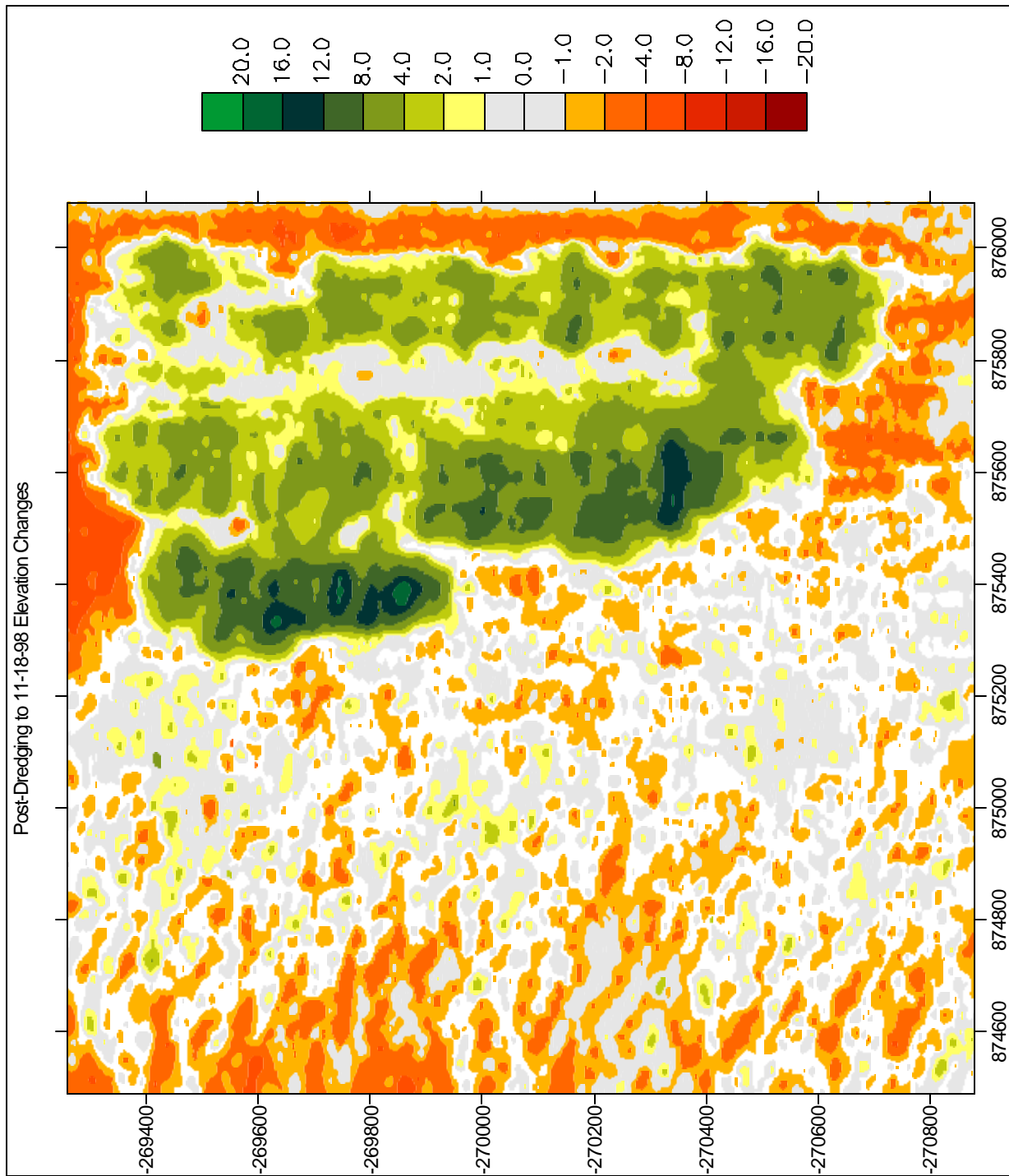


Figure 4-30. Contour maps of North Channel Borrow Site elevation changes (postdredging to November 1998)

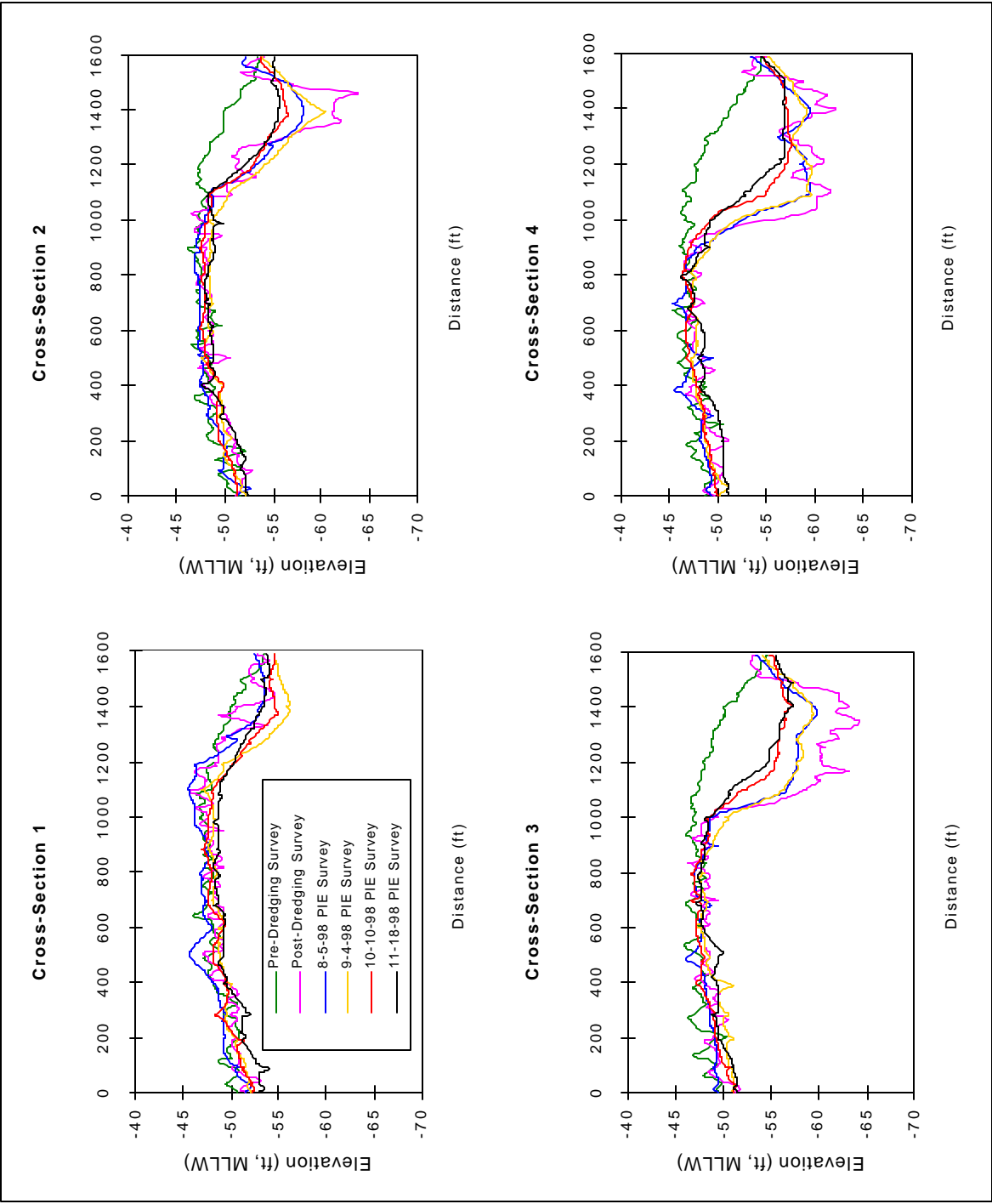


Figure 4-31. Cross sections 1, 2, 3, and 4 of North Channel Borrow Site

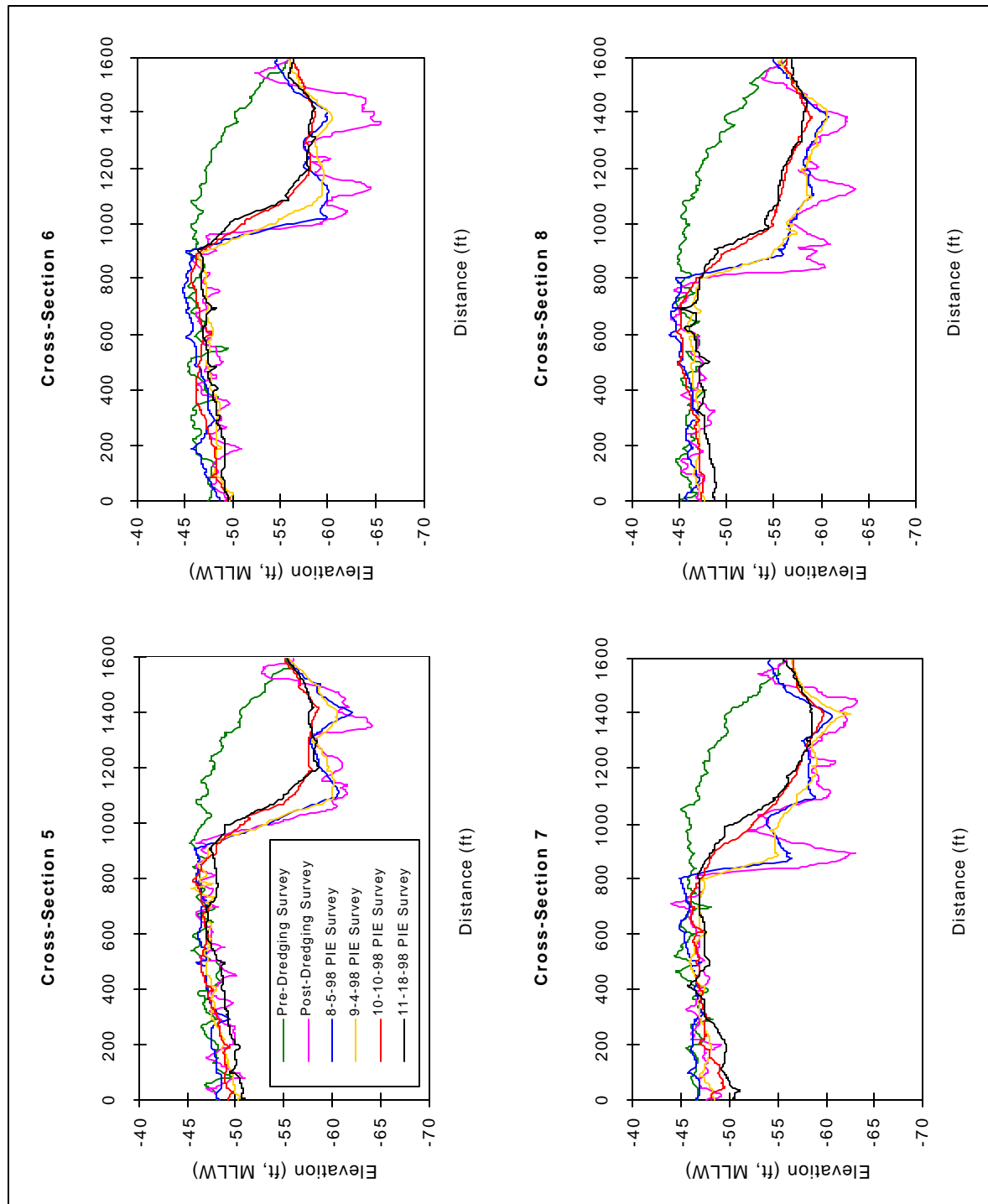


Figure 4-32. Cross sections 5, 6, 7, and 8 of North Channel Borrow Site

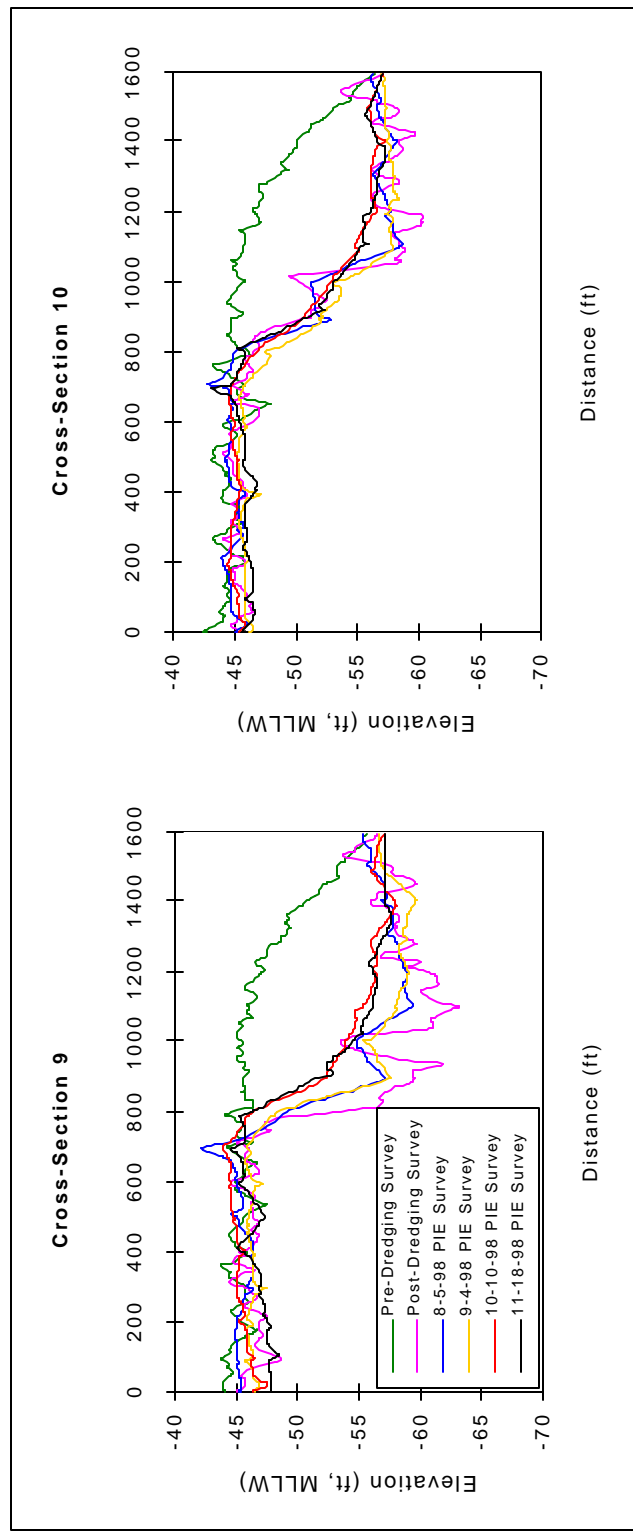


Figure 4-33. Cross sections 9 and 10 of North Channel Borrow Site



<b>Table 4-12</b> <b>Average Change in Depth Along Cross Sections, ft</b>					
<b>Line Number</b>	<b>Pre to Post</b>	<b>Post to 8/5</b>	<b>8/5 to 9/4</b>	<b>9/4 to 10/10</b>	<b>10/10 to 11/18</b>
1	-1.0	-0.5	-2.6	1.0	0.8
2	-5.6	0.7	-1.1	1.8	0.3
3	-9.0	2.1	-0.3	2.1	0.3
4	-8.0	0.9	-0.2	2.0	0.4
5	-8.7	0.5	-0.1	1.8	0.1
6	-9.7	1.7	-0.3	1.4	0.4
7	-9.3	1.6	-0.7	1.9	0.5
8	-10.2	1.5	-0.2	2.0	0.3
9	-9.0	1.4	-0.5	2.2	-0.2
10	-6.6	0.3	-1.0	1.5	-0.1
<b>Average Over Dredged Area</b>	-7.7	1.0	-0.7	1.8	0.3
Note: Negative = Increase in depth (dredging or erosion). Positive = Reduction in depth (accretion).					

<b>Table 4-13</b> <b>Total Volume Changes (cu yd)</b>					
<b>Pre to Post</b>	<b>Post to 8/5</b>	<b>8/5 to 9/4</b>	<b>9/4 to 10/10</b>	<b>10/10 to 11/18</b>	<b>Area of Borrow Site, sq ft</b>
-312,482	41,969	-23,382	69,860	9,346	116,667